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D-21140D Panels, Rack, February 4, 1966

3. REQUIREMENTS.-

3.1 Requirements.- Appendix 1 presents a block diagram of the LORAN-C Monitor. The monitor receives LORAN-C signals from a single chain of stations and compares measured values with expected values for the geographic position of the monitor. In the event observed time difference or signal-to-noise ratio (SNR) values exceed specified limits, or other monitored parameters such as Blink or loss of signal occurs, an alarm signal shall be sent immediately to the Air Traffic Control Point (ATCP) and made available to the Remote Monitoring Subsystem (RMS).

3.2 Equipment to be supplied.- Each monitor furnished shall be complete in accordance with all specification requirements, and shall include the items listed in this paragraph. Instruction books provided In accordance with FAA-D-2494/b shall be furnished in quantities specified

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shall be in accordance with paragraph 3.7.6 of FAA-G-2100d, "Equipment Finish".

3.3.3 Markings.- In addition to the panel marking methods allowed under paragraph 3.9 of FAA-G-2100d, "Marking", use of silk screen marking method is permissible.

3.3.4 Nameplate.- A nameplate shall be furnished in accordance with paragraph 3.10 of FAA-G-2100d, "Nameplates", and shall be mounted on the front panel of the receiver. The nameplate title shall be "LORAN-C MONITOR".

3.3.5 Front panel items.- The following items shall be mounted on the front panel of the monitor. Items c and d may be combined in a single (multicolor) device. Items g, h, and i may be displayed by selection on a single shared display. The items listed in this paragraph shall be considered a minimum requirement.

(a) Power on-off switch (two pole)

(b) Power on indicator - amber

(c) Normal status indicator - green

(d) Alarm status indicator - red

(e) Signal acquisition mode indicator

(f) Signal tracking mode indicator

(g) Display of selected Group Repetition Interval (GRI)

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on printed circuit boards with the exception of large or bulky components not adaptable to such mounting or where such factors as conductor length or capacitive coupling may be critical to equipment performance. All printed wiring boards shall be in accordance with FAA-G-2100d. Individually removable printed circuit boards shall be of the plug-in type with suitable guides and shall be keyed such that they can be inserted only in the correct receptacle and in the correct orientation for proper circuit connection. Printed circuit board edge connectors are allowed. The entire LORAN-C receiver can be considered as a single module and internal parts shall be exempt from the conditions of this paragraph.

3.3.9 Test points.- Test points shall be provided on each module for the measurement of module input and output parameters to permit using external test equipment, to determine that the individual modules meet performance requirements necessary for normal system operations. Test points shall be electronically isolated from the circuit under test, to prevent circuit malfunctions due to test equipment loading and to prevent damage to circuit components caused by improper use of test equipment or shorting of the test point to ground.

3.3.9.1 Extender card.- To facilitate field repair, extender boards shall be furnished and stored in a suitable storage apace within the equipment; A minimum of one extender for each type of receptacle shall

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shall be possible to select for a GRI, any two of the secondary stations of a chain of stations. The receiver shall store the selected GRI and secondary station identifications in nonvolatile memory to eliminate the need to repetitively enter the data.

3.4.1 Absolute accuracy.- The error due to any of the following individual range of signal conditions shall be less than 0.025 microsecond (r.m.s.).

3.4.1.1 Absolute signal level.- The absolute signal level shall range between 25 *to* 105 dB/microvolt/meter.

3.4.1.2 Differential signal level.- The differential signal level shall range between 0 to 60 dB.

3.4.1.3 Differential envelope to cycle difference.- The differential envelope to cycle difference shall lie between ±4 microseconds.

3.4.1.4 Signal-to-noise ratio (SNR).- The useable SNR shall be -10 dB with respect to atmospheric noise, or worse, received in a 30 kHz RF bandwidth. The receiver shall quantify the SNR for each signal received. SNR quantification shall be directly related to the uncertainty in tracking the phase (i.e., phase Jitter) of the received Loran-C signals. A selectable means for averaging, or smoothing, the

SNR quantification over periods from one (1) to thirty (30) seconds shall be provided. The SNR quantity shall be provided as an output to the Loran-C Monitor Processor Unit (3.8).

3.4.1.5 Cross rate interference.- The equipment shall be able to properly acquire and track signals in the presence of cross-rate interference at a level as high as the strongest signal being (or to be) tracked, over the specified range of absolute signal level.

3.4.1.6 Continuous wave interference (CWI).- The signal-to-GUI ratio shall be greater than -20 dB when a notch filter is used. (CWI in dB//(1 uV/m) received in a 30 kHz RF bandwidth.)

3.4.1.7 Noise.- One standard deviation of the time differences shall be less that 0.020 microsecond at a SNR of 0 dB.

3.4.2 Acquisition and settling.- The system shall acquire and settle on the third cycle of received LORAN-C signals over the following range of conditions:

3.4.2.1 SNR.- The SNR shall be -15 dB with respect to atmospheric noise or worse.

3.4.2.2 Continuous wave interference.- The signal-to-CWI ratio shall be

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between 10 to 120 dB/(1 uV/m).

3.4.4 Repeatability.- Repeatability of time difference measurements shall be better than 0.020 microsecond.

3.4.5 Outputs.- The receiver in the LORAN-C. monitor shall provide the following digital outputs to the LORAN-C processor:, (1) time differences between the master and two selected secondary station signals with a resolution of 0.01 microsecond, (2) SNR for the master and the two selected secondary station signals expressed directly in dB with a precision of ±1 dB, (3) upon the occurrence of Blink at a secondary station, Blink messages shall be generated within 12 seconds of initiation by the chain; the message shall identify the station(s) being blinked, (4) upon loss of input signal, an alarm message with lost signal identification shall be generated within 10 seconds, (5) a receiver status output shall be provided to show the current state of the receiver signal processing logic; this state shall indicate at a minimum signal search, cycle selection in process, tracking within specifications, and coasting.

3.4.6 Notch Filters.- A minimum of four notch filters shall be provided; at least one notch filter shall be tunable. A method shall be provided for-examining the frequency spectrum and intensity of interfering signals to assist the operator in setting the tunable notch

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3.5.2 Structural materials.- The receiver antenna shall be constructed of corrosion resistive materials such as anodized aluminum or stainless steel. Hardware, including screws and mounting bracket where used, shall be either stainless steel or bright nickel plated brass. Nickel plating on hardware shall not chip, flake or deteriorate under environmental conditions III in Table III of FAA-G-2100d, "Climatic Conditions". Dissimilar metals shall be in accordance with FAA-G-2100d.

3.5.3 Electrical requirements.- The receiver antenna coupler shall be capable of operating up to 500 feet from the LORAN-C receiver. Coupler power, if required, shall be provided via the receiver. A separate power cable is allowed. The required 500 foot cable shall be-provided by the contractor.

3.5.4 Antenna shipment.- Each antenna shipped shall include all necessary mounting hardware. The contractor shall provide the required cable type and the mating connectors.

3.6 ATCP indicator panel unit.- The following paragraphs describe the requirements for a ATCP indicator panel unit, which when interconnected with the LORAN-C Monitor shall provide receiver status indications at a ATCP location. For design purposes, the distance between the monitor and the ATCP may be up to 500 feet for direct connections with cable to be supplied by the contractor, and up to 100 nautical miles (nmi) via

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one-quarter inch from the edges of the front panel. The holes shall be drilled and countersunk for No. 10 flathead screws.

3.6.2 Finishes and markings.- Requirements for finishes and markings specified in paragraphs 3.3.2 and 3.3.3 respectively, also apply to the ATCP indicator panel assembly.

3.6.3 Nameplate.- A nameplate shall be furnished in accordance with paragraph 3.10 of FAA-G-2100d, "Nameplates". The nameplate shall be mounted on any surface except the front of the ATCP indicator panel. The nameplate title shall be "LORAN-C ALARM".

3.6.4 Power requirements.- Power for the ATCP panel, including [illegible] shall be locally supplied (120 vac, single [illegible]) and shall meet the requirements of paragraph 3.3.2.1.4 of FAA-G-2100d, "AC line connectors and power cord."

3.6.5 Aural alarm.- The aural alarm device shall product a sound or a series of sounds. Maximum output of the aural alarm device, when measured 6 feet from the front of the panel, shall correspond to a sound pressure level between 45 and 50 dB (reference pressure of 0.002 dynes per square centimeter). Provision shall also be made to individually control the level of the aural alarm. The aural alarm shall be continuously adjustable from 45 to 50 dB down to 15 to 20 dB. Upon

detection of an alarm condition, the aural alarm shall be initiated and will continue to operate until normal signal is returned to the receiver or the aural alarm is reset.

3.6.6 Indicator lights.- The illumination of two green lights will indicate that all LORAN-C signal conditions are within established tolerances. Illumination of the red lights will indicate one or more monitor parameters have been exceeded. A separate visual alarm indicator shall be activiated on the monitor equipment (3.10.2.3). A means shall be provided to dim the indicator lights for comfortable day and night use in control towers and for use in darkened en route center facilities.

3.6.7 "Push-to-Test" switch.- The "push-to-test" switch shall sequentially activate the green and red lights and the aural alarm for a period between 2 seconds and 5 seconds each. The Intent of the "push-to-talk" switch is for the controller at the clearance delivery point to check correct operation of the system. This test shall be activated through the monitor processor unit and thus provide a test for the ATCP indicator and the direct wire or telephone connection between the monitor and the ATCP indicator.

3.6.8 Fail safe.- Any failure In the ATCP unit or any unit of the LORAN-C Monitor shall result In display of either no light or of the red

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3.6.8 Fail safe.- Any failure in the ATCP unit or any unit of the LORAN-C Monitor shall result In display of either no light or of the red

a fault exists the processor shall generate and transmit an alarm signal to the ATCP via either a dedicated two wire lint or a modem and dedicated telephone line as selected during installation and to the RMS. Data input to the modem shall be provided via an RS-232-C interface. The processor unit can be separate from or integral with the RMS unit. In no case shall a failure of the RMS adversely affect the operation of the Loran-C Monitor Processor unit. Software used in the LORAN-C Monitor processor shall be documented in accordance with FIPS Publication 38 and shall include document types 3.7 "Operations Manual" and 3.8 "Program Maintenance Manual" as defined therein.

3.8.1 Time difference.- The processor unit shall sample and independently manipulate the two LORAN-C time difference outputs from the receiver. For each time difference, 120 seconds of data sampled at a rate of one sample per second shall be stored. If the system has operated in a normal, non-alarm mode during the 120 seconds, then the first 60 seconds of data shall be averaged and stored. At the beginning of the third 60-second period, providing no alarm has occurred, the first 60 seconds of data can be written over, and at the end of the third period, the second period of 60 samples shall be averaged and stored. This sequence shall be repeated 20 times until 20 one-minute average samples of 60 seconds of data are computed at which instant a lo-minute average sample of time difference of the first 10 samples shall be computed. The 10-minute sample shall be stored in a memory

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An alarm shall be initiated based on time differences computed position, or SNR if the allowable tolerances for either of these parameters are exceeded in seven out of ten l-second samples. An alarm shall be initiated whenever a Blink signal persists for 12 seconds. The last 120 seconds of data and the last ten l-minute samples of time differences and SNR data held in buffer storage shall be stored in non-volatile memory within 1 second of alarm generation. Memory shall be capable of storing data generated by 100 alarms. The memory shall be capable of storing 100 on-off cycles of Blink time data. The alarm time differences and signal-to-noise limits shall be adjustable to allow changes through input/output terminals locally or at the MPS. Each time difference shall have two alarm values (i.e., one above and one below the nominal measured value). The time difference alarm values shall be set to a precision of 0.01 microsecond. A computed position alarm shall be initiated when the distance between the surveyed geodetic position of the monitor, which shall be stored by the monitor, and the computed position exceed the selected alarm limit. The computed position alarm limit shall be set to a precision of ten (10) feet. The processor shall be capable of receiving time difference and position alarm changes up to 10 days in advance and automatically activate new values at a time to be specified when the changes are received. Security levels per 3.10.4 of this document shall be used to prevent unauthorized or inadvertent changes of these limits.

3.8.5 Restoration of normal operation.- The red light at the ATCP and the alarm at the MPS shall be extinguished only after maintenance personnel have completed restoration of the LORAN-C Monitor. A selectable provision shall be included that will permit automatic restoration to normal operation when all preset parameters have been met.

3.9 LORAN-C monitor signal generator.- The generator shall be capable of providing the LORAN-C signals on command. The generator signal shall be capable of being pre-set for a specific GRI, SNR, time differences (normal and fault) and Blink signal in accordance with COMDTINST-M16562.4. On command via the Remote Monitoring Subsystem (RMS) or local maintenance terminal connected through the front panel port (3.10.1.2) the antenna shall be switched off and any one of the pre-set signal conditions shall be initiated and inserted at the antenna input to the coupler.

3.10 Remote monitoring subsystem (RMS).- The equipment specified in this section shall consist of hardware, firmware, and software required to perform the remote monitoring of the LORAN-C Monitor. All equipment supplied shall utilize a common data transmission format as specified herein.

3.10.1 Equipment design.- Specified herein is the necessary hardware,

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between RMS and MPS.

The above functions shall be accomplished and the results made available at ports of the RMS input/output terminal with an EIA-RS-232C interface. The data transmission format used shall meet the requirements of NAS-MD-790 and have a data rate of 2400 BPS synchronous. Monitoring and control functions shall be accomplished via a standard telephone circuit thru a modem. The modem shall have an auto-dial and auto-answer capability. Design use of remote monitoring shall be so pervasive throughout the LORAN-C Monitor that anything controlled or monitored shall be identically controlled or monitored at the MPS location via the modem connection or locally through an input/output terminal.

3.10.1.1 Remote monitor system processor.- The RMS processor shall Interface with the LORAN-C processor equipment. The RMS processor functions, as described below, are independent of and in addition to the LORAN-C processor functions of section 3.8. The RMS processor shall be a microcomputer with associated software, memory, A/D converters; and communications interface controls. The processor shall oversee: (1) automatic fault isolation to the module level; (2) initiation of automatic ground check and analysis of results for errors; (3) programmable certification parameter control; (4) certification testing; (5) monitor integrity testing; (6) system security management and control; (7) system shutdown and reset control; (8) communications

control to operator and LORAN-C Monitor facility via the input/output terminal; (9) LORAN-C Monitor facility controls; (10) maintenance and processed data collections; and (11) collection and dispatching of real time engineering status information. In addition, the processor shall provide the capability for sending the LORAN-C receiver alarm to the ATCP and MPS and/or the local input-output terminal. The RMS processor shall be designed so that control of all adjustments and all indications resulting therefrom shall be via the MPS or the local maintenance terminal. The RMS processor shall provide the capability of collecting all available data from the LORAN-C facility equipment on a programmable basis and on request. The data collected shall be date/time tagged, stored in memory, and made available via an input/output terminal on a programmable basis, and on request. The RMS processor shall accept and forward hardware/software interrupts received from the other monitor equipment and shall generate an appropriate interrupt upon detection of a fault or change of any monitored parameter exceeding tolerance limits. The processor shall contain the functions required to perform fault diagnosis to a replaceable module, upon itself, and upon the LORAN-C Monitor equipment. The processor, when in a failure mode or when in a test or certification mode, shall initiate an alarm at the ATCP.

3.10.1.2 Processor front panel.- The front panel shall have inputs to an EIA-RS-232C connector port wired for attachment of an input/output terminal, keyboard/display or keyboard/printer.

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any measured parameter in the LORAN-C Monitor. The RMS software shall provide the capability of obtaining from memory any and all stored data which shall have been identified by date and time. The source of data shall be identified (e.g., LORAN-C, maintenance data, or test point). The capability to test the entire LORAN-C Monitor also shall be resident in the RMS software as a separate routine. Documentation shall in accordance with FIPS PUB 38 and shall include document types 3.7, "Operations Manual", and 3.8, "Program Maintenance Manual" as defined therein.

3.10.2.1 Data collection software.- All data shall be available in digital form on the data buss(es). These data shall be refreshed in memory often enough to assure accurate retention upon a fault condition and the processor shall store the prefault, post-fault, false alarm, and post alarm data in non-volatile memory(ies) for later use in fault diagnosis.

3.10.2.2 Fault diagnosis software.- Automatic means shall be provided to diagnose and indicate the cause of a fault to the lowest level replaceable printed circuit board or module. The resulting data shall be accessible by output/input terminal at the LORAN-C Monitor and MPS for recall upon demand:

3.10.2.3 Control software.- Control of the LORAN-C Monitor shall be

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of any interrupts which may occur.

3.10.4 Security.- Three levels of reprogrammable site peculiar safeguard of access to data and control shall be provided. The first level of access shall be required to permit access to copy all data. A second level of access shall be required to permit copies of all data and to permit adjustment of non-critical parameters (e.g., those parameters not associated with certification parameters or monitor fault threshold establishment). A third level of access, requiring operator identification, shall. be required to permit access to copy data and to adjust any controls,, including those associated with certification parameters or fault threshold. Additionally, at the third level of access, the last day/time tagging and operator identification (such as initials) must be stored and must accompany all certification data. The security method shall include the option for a later change by the government to a method using a dedicated telephone lint and modem with access only through the MPS. Under the optional security method there shall be no security provisions in the monitor.

3.10.5 Interface.. Communication interface shall be provided from the RMS processor described in 3.10.1.1 to those below:

(a) Landline port, for a dedicated 4-wire landline telephone connection between the Monitor and the ATCP and shall be compatible with

RMS Interface Control Document (ICD) NAS-MD-790 except for special signaling procedures necessary to provide for status change interrupts, primary power failure interrupts, and landline testing. Data rate of 2400 BPS synchronous shall be the nominal rate used.

(b) One port for a direct two wire connection between the Monitor and the ATCP.

(c) One EIA-RS-232C port compatible with a line oriented input/output terminal with a data rate of 9600 BPS. This port will be used for local servicing at the site and communicating with the local processor.

(d) Auto-dial/auto-answer modem port for connection to a telephone line between the Monitor and the MPS. This port shall be compatible with the RMS ICD NAS-MD-790 when called by an ICD compatible input/output terminal.

(e) The contractor shall provide interfaces to accommodate the LORAN-C antenna coupler and signal generator. These interfaces shall connect to the chassis.

3.10.6 Communications.- The communication between the MPS facility and the RMS shall be via 4-wire, service type 5, voice grade telephone lines

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(d) Auto-dial/auto-answer modem port for connection to a telephone line between the Monitor and the MPS. This port shall be compatible with the RMS ICD NAS-MD-790 when called by an ICD compatible input/output terminal.

(e) The contractor shall provide interfaces to accommodate the LORAN-C antenna coupler and signal generator. These interfaces shall connect to the chassis.

3.10.6 Communications.- The communication between the MPS facility and the RMS shall be via 4-wire, service type 5, voice grade telephone lines

the output data of the receiver. Receiver sensitivity, data formats and signal levels shall be of primary importance.

(c) LORAN-C Processor output - A check shall be incorporated which measures the output data stream from the LORAN-C processor input/output terminal.

3.10.9 LORAN-C monitor certification.- LORAN-C monitor certification measurements shall be verified with a stored or printed copy of the measurement information after the successful completion of the checks listed in 3.10.8 and this paragraph, as follows:

(a) LORAN-C signal generator - Prior to testing the monitor processor output, the output signal of the LORAN-C signal generator shall be measured and certified as true LORAN-C 100 kHz pulses with characteristics as defined in the USCG document "Specification of the Transmitted LORAN-C Signal" COMDTINST M16562.4 (July 1981). The generator controls shall be varied over the entire range of LORAN-C signal characteristics designated for the specified monitor location.

(b) LORAN-C monitor tests (generator) - These tests shall employ the site specific LORAN-C signal generator to certify the monitor output under controlled LORAN-C frequency, time, and pulse characteristics. Both the upper time difference and lower time difference signals Shall

the output data of the receiver. Receiver sensitivity, data formats and signal levels shall be of primary importance.

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(b) LORAN-C monitor teats (generator) - These tests shall employ the site specific LORAN-C signal generator to certify the monitor output under controlled LORAN-C frequency, time, and pulse characteristics. Roth the upper time difference and lower time difference signals shall

specifically Identified external teat equipment.

3.11.2 Reliability program.- The contractor shall conduct a reliability program as described in FAA-G-2100d paragraph 3.3.5, "Reliability". The upper teat mean time between faults (MTBF) of the LORAN-C receiver, Loran-C processor, the remote monitoring subsystem and power supply (considered as a system) shall be 10,000 hours. The same MTBF of 10,000 hours shall apply to the ATCP.

3.11.3 Maintainability program.- The contractor shall conduct a maintainability program as described in FAA-G-2100d paragraph 3.3.6, "Maintainability". The program shall include a demonstration phase in accordance with FAA-G-2100d, paragraph 4.3.6, "Reliability and/or Maintainability Demonstration Tests", and shall establish that the following requirements are *met:*

(a) *The* mean time to repair (MTTR) shall be no *more* than 30 minutes. In addition, 90 percent of all repairs shall be accomplished *In* not more than 15 minutes, and no single repair shall require more than 60 minutes.

(b) The required time to accomplish preventive maintenance shall not exceed 60 minutes In 2,190 hours of operation. Preventive and corrective-maintenance shall be conducted at intervals no greater than

once in 2,190 hours of operation.

3.12 Training.- The Contractor shall develop maintenance and operator courses and conduct these training classes in accordance with contract requirements, and FAA Standard, FAA-STD-028, Contract Training Programs.

4. QUALITY ASSURANCE .

4.1 Quality assurance provisions.- The contractor shall be responsible for providing test procedures and conducting all inspection and testing to assure product conformance to the satisfaction of the government, with the requirements of this specification and shall establish and maintain a quality control program in accordance with FAA-STD-013.

4.2 Design qualification test.- Design qualification teat procedures shall be performed under normal conditions as described in FAA-G-2100d paragraph 4.3.2, "Design Qualification tests". Tests and verification included in FAA-G-2100d Table V, "Equipment Performance Requirements versus Condition of A.C. Primary Input Power," shall be used for design qualification.

4.2.1 Normal teat conditions.- Design qualification tests shall be made under normal test conditions described in FAA-G-2100d, paragraph 3.3.1.5.1, "Nominal Design and Normal Test Values".

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LORAN-C Monitor Signal Generator

Remote Monitor System Processor

Memory

Clock

Data Collection Software

Fault Diagnosis Software

Control Software

Certification Software

4.4 Production test.- Production tests shall be made under normal test conditions in accordance to FAA-G-2100d paragraph 4.3.4, "Production Tests". The specific production tests required shall be those submitted by the contractor in accordance with FAA-G-2100d, paragraph 4.2, "Contractors Detailed List of Tests", and. approved by the Contracting Officer.

4.5 Design report approval. The contractor shall submit a preliminary design report to the Contracting Officer for approval. Approval must be received before the contractor may proceed with construction of the first equipments. Such approval should be based on Government determination of compliance with this specification.

4.6 Configuration management.- A configuration management program shall be established in accordance with FAA-1800.8E and MIL-STD-483, and

LORAN-C Monitor Signal Generator

Remote Monitor System Processor

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5.1 General.- Unless otherwise specified in the contract, the equipment shall be prepared for domestic shipment in accordance with the following subparagraphs.

5.2 Preservation and packaging.- Preservation and packaging shall be in accordance with specification MIL-E-17555G, Level A.

5.3 Packing.- Packing shall be in accordance with Specification MIL-E-17555G, Level B. No more than one set of equipment and associated items shall be packed in each shipping container.

5.4 Marking.- Each package and shipping container shall be durably and legibly marked with the following information:

(a) Name of item and FAA designation
(b) Serial number
(c) Quantity
(d) Contract number
(e) National stock number
(f) Gross weight of container
(h) Manufacturers name

6.0 Notes.- None.

5.1 General.- Unless otherwise specified in the contract, the equipment shall be prepared for domestic shipment in accordance with the following subparagraphs.

5.2 Preservation and packaging.- Preservation and packaging shall be in accordance with specification MIL-E-17555G, Level A.

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(a) Name of item and FAA designation
(b) Serial number
(c) Quantity
(d) Contract number
(e) National stock number
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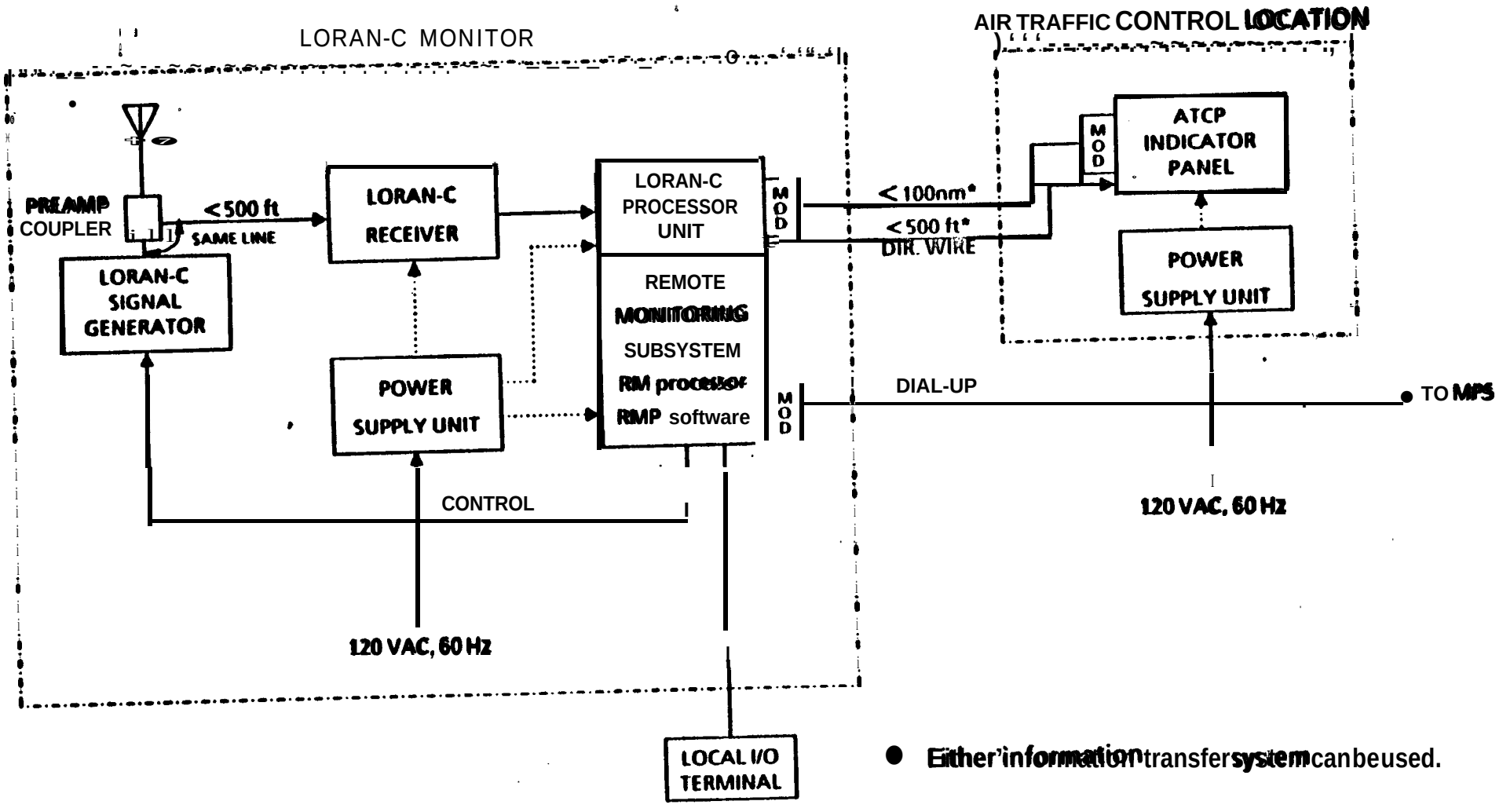
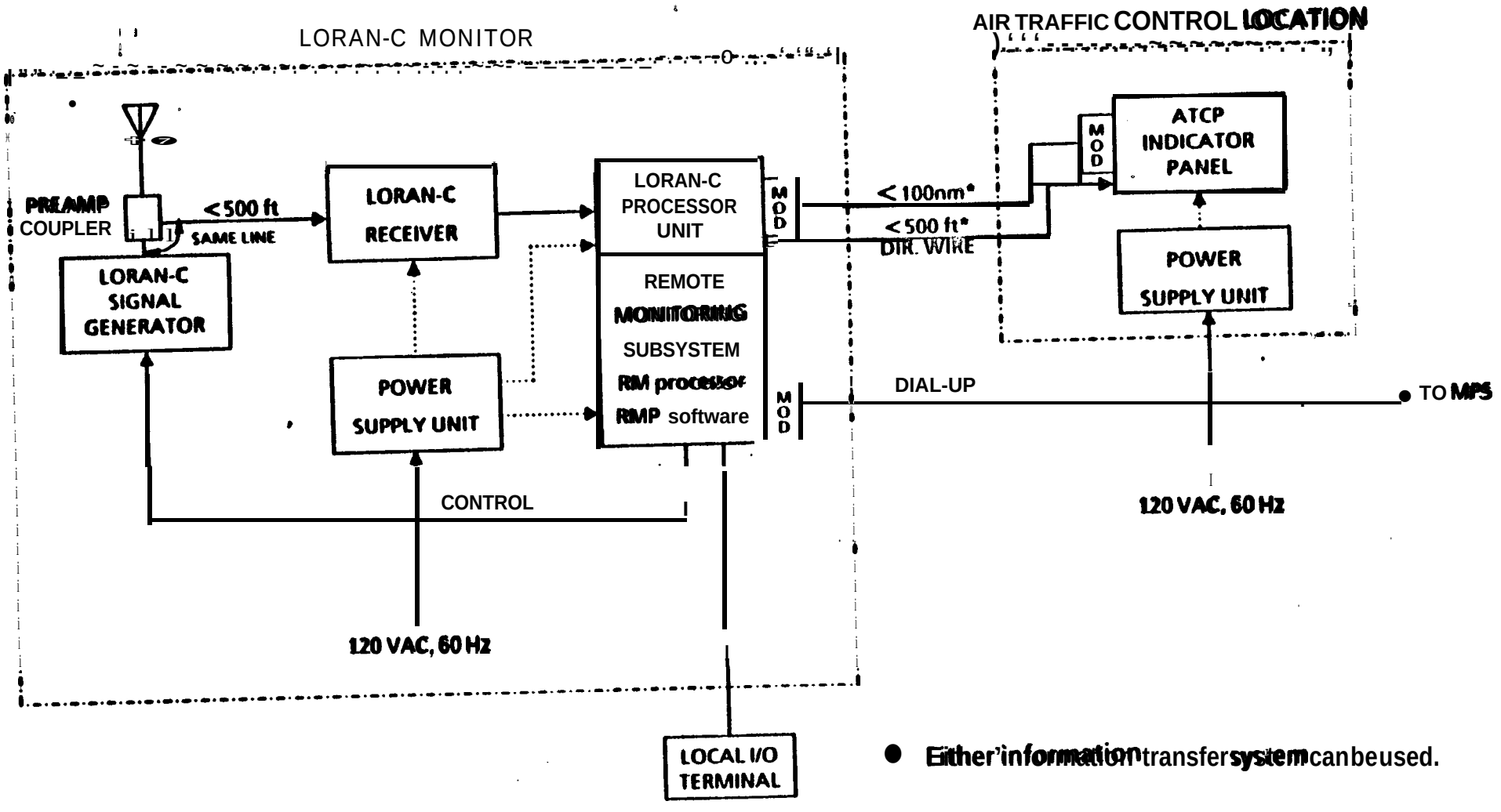
6.0 Notes.- None.



● Either information transfer system can be used.

BLOCK DIAGRAM OF LORAN-C MONITOR

APPENDIX 1



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BLOCK DIAGRAM OF LORAN-C MONITOR

APPENDIX 1

FAA-E-2762
November 26, 1965

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SPECIFICATION

LORAN-C MONITOR